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ABSTRACT

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ON PREDICTING SUCCESS IN TRAINING FOR MALES AND FEMALES: MARINE CORPS CLERICAL SPECIALTIES AND ASVAB FORMS 6 AND 7

Stephen B. Dunbar
and
Melvin R. Novick

ONR Technical Report 85-2

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On Predicting Success in Training For Males and Females: Marine Corps Clerical Specialties and ASVAB Forms 6 and 7*

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Abstract

The presence of differences between prediction systems for males and females is investigated through a detailed study of clerical specialties in the Marine Corps. When various aptitude composites are used to predict success of recruits in training, sizeable differences in regression functions are found between male and female groups. The paper shows that selected deletion of extraneous ASVAB variables maintains overall predictive efficiency but does not remove the differences between male and female regressions. However, when the attainment of a high school diploma is considered, differential prediction is substantially reduced. Implications of these empirical results for the general problem of military personnel selection are discussed.

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On Predicting Success in Training for Males and Females: Marine Corps Clerical Specialties and ASVAB Forms 6 and 7

The literature in personnel selection and classification is replete with examples of what has been called situational specificity in predicting job performance. Unique characteristics of tasks peculiar to a particular job or job family have been thought to moderate the relationship between a global set of predictors and on-the-job performance (cf. Ghiselli, 1966). Situational specificity in the prediction of success in training for military occupations, for example, has been a focus of attention for test validation at least since Stewart's (1947) analysis of occupational differences in scores from the Army General Classification Test. Accordingly, validation research performed in the military since that time has concentrated on the relation between test scores and training success within specific occupational groups (as in, for example, Valentine, 1977).

A recent case against the concept of situational specificity has been made in the work of Schmidt, Hunter and associates (see, for example, Schmidt & Hunter, 1977 and Schmidt, Hunter & Pearlman, 1981). The procedures outlined in their work for studies of validity generalization have shown that a substantial amount of variability in observed validity coefficients (predictor-criterion correlations) could be due to the presence of statistical artifacts such as range restriction, criterion unreliability and simple sampling error. Schmidt and Hunter (1981) also cast doubt on the general presence of race-differentiated prediction, claiming that "cognitive ability tests are equally valid for minority and majority applicants and are fair to minority applicants in that they do

not underestimate the expected job performance of minority groups" (p. 1128).

Although the evidence amassed by these authors is formidable, few would question the need for continued investigation of moderator variables in selection contexts. As noted by Linn and Dunbar (1985), for example, a difference exists between concluding that validities can be more easily generalized than once thought and claiming that situational specificity does not exist. Tenopyr and Oeltjen (1982) express similar sentiments regarding the validity generalization and situational specificity dichotomy, while Novick (1982) provides specific illustrations of the importance of continued study of group differences in settings where inference is crucial.

The investigation of differences in prediction for males and females can be viewed as an instance of the specificity concept; however, explanations of the causes of this kind of specificity are clearly different from those made for specificity by job site, for instance, where causes might not be entirely psychological in nature. The notion that a particular moderator effect such as the male-female dichotomy can be viewed as an instance of the specificity concept stems from an assumption that causes of such differences are complex and that the demographic variable is only an available surrogate measure of these causes. Although arguments about whether investigations of differences in criterion-related validity should be conducted with correlation coefficients (differential validity) or regression parameters (differential prediction) have clouded some of the important substantive issues in such studies, variation in within-group predictions has been observed in both educational and employment settings. As noted by Linn (1982), however, a

disproportionately small number of these studies have examined differences for men and women. The Defense Advisory Committee on Military Personnel Testing has noted the existence of differences in regressions for men and women and has spoken to the need for more detailed investigations of these differences in predicting training success in the military (cf. Defense Advisory Committee, 1983).

This paper addresses the general issue of differential prediction for men and women by means of a detailed analysis of selected job classifications in the clerical specialty area of the Marine Corps. Our particular interest lies in the identification of differences between predicted training success for males and females based on ASVAB composite scores and subtests typically used for selection. The search for alternative predictive composites that yield equally accurate, non-differentiated regression functions is another concern of the analysis.

Related Research

The study of different prediction systems for men and women has a growing history in Air Force technical training programs. Gordon (1953) was the first to find stable differences between regression equations of men and women--female performance was consistently underpredicted in this early study. In a more recent validation study of composites used for predicting performance in Air Force mechanical training courses, Valentine (1977) found substantial differences between the predicted scores based on male and female regression equations in nine courses. For example, differences between observed female means and the female means predicted from the male regressions of course grades on the selection

composite ranged from .10 to .43 female standard deviations (Linn, 1984). For the nine training courses examined, mean female performance was underpredicted by an average of .28 female standard deviations.

In contrast to the large discrepancies noted by Valentine (1977), Webster, Booth, Graham, and Alf (1978) found limited evidence for differential prediction for men and women in Navy hospital training schools. These authors examined the impact of a common prediction equation on the number of false-positive and false-negative decisions made for various cut-scores on the predictors. They found significant differences between males and females in the proportion of recruits misclassified, with males showing a higher proportion of misclassifications due to underprediction of their criterion scores using a common equation. Although the criterion used by Webster, et al is different, the contrast this study poses with the previous Air Force results makes it reasonable to expect differences between regressions for men and women to be, at least to some extent, course specific. We return to this observation in discussion of the results presented below.

In a study of the regression of undergraduate grades on an ACT battery, Gamache and Novick (1985) investigated the presence of male-female differentiated prediction for selected college programs (liberal arts, business, medicine, etc.). They identified differences between the predictions of grade-point average from ACT scores to be as much as .45 female standard deviations on the criterion when the within-group regressions were evaluated at the female mean on the predictor. Again, the effect was to underpredict female criterion performance in most programs and with most variables. Similar tendencies for male equations to underpredict female performance have been observed in educational settings by

Linn (1973), ACT (1973), and Breland and Griswold (1982). The findings of Breland and Griswold (1982) are noteworthy in that underprediction of female performance was consistent throughout the predictor score scales and was documented through traditional regression techniques and a contingency table analysis.

Method

Data Source

Data for this report come from validation files used in a study of the Armed Services Vocational Aptitude Battery (ASVAB), Forms 6 and 7 (Sims and Hiatt, 1981). We limit consideration to recruits assigned to one of nine training courses classified as clerical specialties. Table 1 lists these clerical specialties and sample sizes available for analysis. The proportion of the total sample that is female ranges from .10 for Basic Supply Stock Clerks to .35 for Administrative and Unit Diary Clerks.

Insert Table 1 About Here

Predictor variables of special interest in this study are the ASVAB Clerical Composite (CL) used for selection and the four ASVAB subtests from which the Clerical Composite is constructed. These subtests are Arithmetic Reasoning (AR), Word Knowledge (WK), Attention to Detail (AD), and an attitudinal measure called the Attentiveness Scale (CA). All ASVAB variables except CA were transformed to standardized scores using

the corrected conversion tables for Forms 6 and 7. This placed the composite on a scale with a mean of 100 and a standard deviation of 20 and the subtests on scales with means of 50 and standard deviations of 10. Because no standard scale was developed for CA, its scores range from 0 to 20. The available criterion variable is final course grade (FCG) in training. These scores are reported on a nominal scale of 0-100, with values for most training courses falling between 70 and 100.

Procedure

The distributions of ASVAB predictors and course grade criterion were first examined for ceiling and/or floor effects which might jeopardize the linearity and homoscedasticity requirements of the least squares regressions and for outliers. In several training courses, observations were deleted because of extreme scores on the criterion - Sims and Hiatt (1981) note that extremely low criterion scores for these courses appear to be arbitrarily determined. Area transformations of the criterion variable were also considered in situations where heteroscedasticity appeared to be a concern; however, no such transformations had a marked effect on the joint criterion-predictor distributions. Separate least squares regression equations for predicting training success were determined for the clerical composite, CL, and for each of the subtests of which it is composed. The subtests were also considered as multiple predictors of training success. Although the data available for analysis are clearly subject to the effects of range restriction on the independent variables, no attempts to remove these effects were considered in this study. One justification for this is the focus in this study on regressions rather than correlations; these are less effected by explicit

selection. The reported amounts of criterion variance accounted for by ASVAB test scores should, however, be interpreted accordingly.

Preliminary tests of null hypotheses of equal within-group slopes and intercepts were conducted using conventional techniques. For these tests an alpha level of .10 was established for rejection, the rationale being that Type II errors should be lessened in the study of differential prediction. In addition to these tests, regions of the predictor score scale where important differences between male and female regression functions existed were identified using the Johnson-Neyman technique. This technique identifies values on the score scale where the 100 (1 - p) percent prediction interval for differences between predicted scores does not include zero. Regions identified with the Johnson-Neyman analyses were used along with the observed predictor distributions to determine the proportion of each sample that might be affected by differential prediction. A concise description of the Johnson-Neyman procedure is provided by Potthoff (1984).

The search for alternative predictive composites was guided by the approach described in Gamache and Novick (1985). This is basically an iterative search for a set of predictors (or a weighted composite of predictors) providing accuracy sufficient for administrative purposes while at the same time minimizing the proportion of individuals affected by any differential prediction that might exist.

Results

Within-group means and standard deviations for the nine courses are reported in Table 2. While the distributions of composite scores vary

from course to course, there seems to be a marked tendency for females to have higher means on the clerical composite. Mean differences between males and females range from 7 to 15 scaled score points with females scoring an average of 9 points higher than males across the nine schools. Female standard deviations on the selection composite also tend to be smaller than those for males. The distributions of the criterion, on the other hand, show mean differences between males and females that range from virtually no difference for the Personal Financial Records course to 4.7 score points in favor of females for the Aviation Supply course. Although criterion standard deviations for men and women in the same training course are similar, female SD's are smaller than male SD's for all but two courses.

Insert Table 2 About Here

The results of within-group regression analyses are presented in Table 3, which contains slopes, intercepts, and standard errors of estimate for each of the nine clerical schools. Here ASVAB variables have been considered as single predictors of training success.

Insert Tables 3 And 4 About Here

Regression parameters and standard errors for the multiple predictor analyses appear in Table 4.

Inspection of the regression parameter estimates in Table 3 reveals substantial differences between male and female prediction equations for all training courses using the Clerical composite as sole predictor.

Although the estimates no doubt are influenced by an unspecified degree of administrative and voluntary selection of recruits into other training courses for which they qualify on the basis of other ASVAB composites, the male-female differences, which vary across courses, are not likely to be explained entirely by differences in selectivity. Of particular interest in the regressions involving CL, for example, are apparent differences between male and female slopes in Unit Diary, Basic Supply Stock, Personal Financial Records and the three aviation-related courses. In addition, where differences between within-group standard errors of estimate exist, a general trend toward smaller errors is present for females.

Smaller standard errors of estimate for females are also seen in the full regression models for subtests as multiple predictors in Table 4. Also observed from the coefficients in Table 4 is the fact that the male-female grouping variable (MF) receives a positive weight in six of the nine training courses studied even after the effects of interaction terms are considered. With males and females coded 0 and 1, respectively, these results indicate female performance on the criterion to be, in some cases, substantially higher in clerical training than would be predicted on the basis of the male regression equations for the individual subtests. The combination of MF and the interaction terms leads to average female performance that is higher than the regression equations for men would predict it to be for all courses, although the degree varies from course to course. Another observation of note with respect to these results is the relatively small contribution being made to either male or female prediction by AD in nearly every training course.

If one corrects the weight estimated for CA for scaling differences, one sees a small contribution being made by that variable as well.

Differences between male and female within-course regressions expected to be stable over sampling are indicated in Table 5, which contains the results of hypothesis tests of parallel and coincident regressions. F-ratios and rejection levels are reported for all schools using both single and multiple predictor models. In general the statistics in Table 5 indicate greater similarity between the slopes of male and female regression functions than between their intercepts.

Insert Table 5 About Here

The null hypothesis of parallel regressions using the Clerical Composite is rejected in three of nine courses, and is nearly rejected in a fourth course. Although evidence for differences between slopes when individual subtests are considered exists for three courses, the salient feature of the results in Table 5 is a consistent trend toward differences between intercepts, regardless of the particular variables used for prediction. The number of rejections of equal intercept hypotheses is much greater than would be expected if observed differences were due to sampling fluctuations alone.

As indicated earlier in the paper, the Johnson-Neyman technique is perhaps best suited to the concerns of this study, since our focus is on assessing the importance of contrasting regressions to selection decisions. Regions identified using this technique for the single predictor cases are provided in Table 6 along with the proportions of the total sample and female sample potentially affected by the observed

differences. When CL is used to predict course grades, the weighted average proportion of females with test scores in the Johnson-Neyman region (with female sample sizes as weights) is .78 across courses for which a region exists, and .60 across all courses. The proportion of females in these regions is largest in the Administrative sample (.86) and smallest in the Personal Financial Records sample (.44). The specific regions of the CL scale identified show that a nominal cut score for selection of 100 would lie in a region of important difference between male and female regressions for the Administrative and Aviation Operations courses and on the edge of such a region for the Personal Financial Records course. In addition, the female mean lies within the difference region provided by the Johnson-Neyman technique in all courses with regions for the selection index, CL, except Personal Financial Records.

Insert Table 6 About Here

A further indication of the magnitude of male-female differences is provided in Table 7, which contains differences between criterion predictions for men and women at the mean of the female predictor distributions, expressed in female standard deviation units. Negative differences here indicate the underprediction of female performance on the criterion, while positive ones would indicate overprediction. The values reported in Table 7 show the contrast between predictions for men and women to be quite uniform and dramatic regardless of training course or predictor variable considered. The male-female differences reported in Table 7 range from .14 female standard deviations for the CL composite

in the Supply Stock course to 1.03 female standard deviations for CA in the Aviations Operations course. A weighted average difference of about one third of a standard deviation when the composite is used as sole predictor calls into serious question the hypothesis that females are not adversely affected by selection on the basis of a prediction equation for males. Indeed, the average number of scaled score points that would have to be added to an average female composite score to obtain the criterion score predicted by the female equation is 9.88. An appropriate degree of caution is in order regarding the stability of male-female differences for training courses with small sample sizes for women. However, the fact that these differences are in the same direction as differences found in the Gordon and Valentine studies cited earlier lends support to an argument that women may well be adversely affected by use of a combined equation for selection.

Insert Table 7 About Here

Alternative Predictive Composites

The use of ASVAB composites for predicting training success is obviously complicated by the kinds of within-group differences observed in this study. Users of ASVAB are faced with a dilemma encountered by many when issues of bias in selection arise. Separate algorithms for many training courses will no doubt lead to more accurate predictions, but they make selection rules complex and sometimes difficult to justify from a policy standpoint. Gamache and Novick (1985) have discussed these problems in the context of educational selection and suggest several

approaches for dealing with the problem. Clearly, a search for alternative composites, which ameliorate the problem of differential prediction without sacrificing predictive accuracy, is suggested by the results heretofore considered.

Several alternative regression models for Marine Corps clerical specialties were evaluated in an attempt to develop a more suitable selection index. Models in which selected ASVAB subtests were deleted yielded small decrements in the amount of differential prediction observed for some training programs; these decrements typically involved interaction terms. Table 8, for example, contains the full regression models that consider AR and WK as predictors. Least squares estimates of regression weights, standard errors of estimate, and squared multiple correlations are presented. One can see from the estimates in Table 8 that the regressions involving only AR and WK do not sacrifice much in terms of predictive accuracy. With AD and CA removed from the equation, the standard errors of estimate increase by at most two-tenths of a criterion score point. The average reduction in the percentage of variance explained by AR and WK versus that explained by all predictors is 1.6% for men and 2.4% for women.

Insert Tables 8 and 9 About Here

One also observes from the estimates in Table 8 that differences between intercepts still remain, despite the removal of AD and CA. Tests of hypotheses of differential prediction using AR and WK, shown in Table 9 corroborate this finding. Null hypotheses of parallel regressions failed to be rejected for all of the courses. However, the combined

influence of the group and interaction terms led to rejection of the coincidence hypotheses in all but two of the training schools. As shown below, the restricted set of predictors actually slightly increased, rather than decreased, the average magnitude of differences between male and female predictions.

The consistent differences between intercepts of male and female regressions can have a number of explanations. In any case, the consistent underprediction of female performance suggests that the effect of a component of performance on the relevant criterion is specific to women. Initial analyses make apparent that other ASVAB variables considered in this study do not adequately measure such a component. Indeed, indicators of behavior that could effect success in a training program to a greater extent than they could high scores on selection tests (such as level of general education or previous experience in a particular area of training) are likely better at characterizing the component that is missing from the regression models considered thus far.

Although no indication of previous experience is available in the present validation context, Marine Corps recruits are distinguished by whether or not they have received a high school diploma. Accordingly, differential prediction tests were conducted for a restricted group of recruits with high school diplomas, using CL as single predictor and AR and WK as joint predictors of training success. Sample size limitations precluded a complete analysis of these data with education level considered an independent variable in addition to MF and the ASVAB variables.

Hypotheses of no difference between male and female intercepts were rejected at the 10 percent level for only four training courses when

using the two models. Differences between slopes were detected for two training courses with the composite as predictor and for no courses with AR and WK as predictors. The Johnson-Neyman technique applied to the high school graduate sample identified regions for the same five training schools for which regions were identified using CL in the complete sample. However, the proportions of recruits potentially affected by contrasting male-female regressions were generally smaller than the corresponding proportions when all applicants were considered.

Comparisons between male and female predictions for the sample of high school graduates and the total sample, provided at the female mean in Table 10, indicate a that a substantial reduction in differential prediction can be achieved by using information about the receipt of a high school diploma. Although the predictions in Table 10 clearly show that the AR-WK combination yields differences for men and women of greater magnitude, the predictions for the sample of high school graduates show smaller differences for both regression models shown. The most pronounced reductions are observed in the Administrative, Unit Diary, and Communications Center courses when the composite is the sole predictor. Although females continue to be underpredicted, the magnitude of that underprediction is reduced on average with an additional consideration of high school attainment. Again, these results should be viewed as suggestive rather than definitive indications of the importance of non-test variables in reducing prediction differences between men and women because of the small sample sizes for women in several training courses.

Insert Table 10 About Here

Discussion

The results of this study present a challenge to any strong version of the validity generalization hypothesis. Sizeable differences between regressions and predictions were found for males and females in various Marine Corps clerical specialties. The Johnson-Neyman analysis demonstrates that prediction systems are not identical across groups for all training schools using the available personnel data. This is not to say that the criterion-predictor relationship is not generalizable. Rather, we suggest that it is best viewed with respect to clusters of specialties for which greater homogeneity exists across male and female cohorts and with due regard to relevant non-test variables such as attainment of a high school diploma.

The fact that a reduction in differential prediction was observed when differences between males and females in high school attainment were removed is noteworthy. In other selection contexts, such as college admissions, one routinely observes that optimal prediction occurs with some weighted combination of admission test scores and a measure of high school performance such as class rank or grade-point average. The argument suggested by the analyses in this paper would advance the hypothesis that individual and group differences related to performance on the training criterion are explained in part by a performance composite much

like high school achievement. To ignore such information in the assignment of recruits to clerical specialties creates systematic group differences in expected performance. This is the kind of hypothesis that should be validated in other selection contexts and with sets of data containing a larger representation of women.

One referee has suggested that the male-female variable may be confounded with socioeconomic status (SES) because of higher selectivity in the female population. A glance at the means and standard deviations of CL, in particular, from Table 2 confirms this selectivity, although it is not clear that the restriction of range implied by sample statistics is not a characteristic of the female applicant pool itself rather than the result of differential selectivity into the validation sample. The finding that attainment of a high school diploma reduces differential prediction is consistent with the hypothesis of SES confounding because of the known positive relationship between SES and high school achievement. However, the suggestion is not damaging to the important conclusions of this study. Differences between male and female regressions are apparent with the use of this version of ASVAB and the available personnel data and, furthermore, these differences can be reduced by the use of a prior education variable in prediction algorithms. In addition, whatever the complex of variables is that causes the male-female differences observed here, our results provide some disconfirmation of a strong statement that ASVAB composites and subtests make essentially the same predictions regardless of other characteristics of Marine Corps trainees. Were the present results inconsistent with previous findings from studies with large and balanced samples of men and

women, this position would be more difficult to support on the basis of present findings alone.

The same referee also suggests that race may be another confounding factor because these tests tend to overpredict for blacks (cf. Sims & Hiatt, 1981). This hypothesis has not been examined here even though the present authors recognize it as a possibility. For the overprediction phenomenon typically observed for blacks in race comparisons to effect the male-female differences observed in this study, the female samples would have to have a markedly higher proportion of white trainees than the male samples.

A pragmatic view of the problem of differential prediction in employment testing would suggest a different solution. Discussions within the Defense Advisory Committee have made clear to these authors that the use of separate equations for men and women, or for blacks and whites, is not a palatable solution to the problem of contrasting regressions for important subpopulations. Rather, palatable solutions are those that involve blocking on non-sensitive variables, such as education level, that correlate with sex, race, SES, and a future performance criterion. When this is feasible, the resulting selection procedure is less likely to create a relative disadvantage for members of any particular group, however membership in that group happens to be defined. Using information about the receipt of a high school diploma in predicting training success in the military is a useful first step in the employment of such variables.

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Table 1

Clerical Specialties and Corresponding Sample Sizes

Specialty	Total	Male (%)	Female (%)
Administrative	1287	841 (65)	446 (35)
Personnel	170	125 (74)	45 (26)
Unit Diary	148	96 (65)	52 (35)
Basic Supply Stock	955	848 (89)	107 (11)
Pers. Fin. Records	326	263 (81)	63 (19)
Aviation Operations	233	190 (82)	43 (18)
Aviation Maint. Admin.	200	166 (83)	34 (17)
Aviation Supply	458	408 (89)	50 (11)
Communications Center	656	575 (88)	81 (12)
Totals	4433	3512 (79)	921 (21)

Table 2

Means and Standard Deviations for Males and Females on FCG and ASVAB Predictors

Training Course	Variable	Male Mean	Male SD	Female Mean	Female SD
Administrative	FCG	82.0	7.0	86.6	6.3
	CL	106.9	14.0	117.1	10.2
	AR	50.8	8.3	52.6	7.4
	WK	53.2	7.1	56.9	5.6
	AD	54.0	10.8	61.4	9.9
	CA	12.3	3.3	13.6	2.9
Personnel	FCG	89.2	5.4	91.4	4.3
	CL	108.4	13.4	114.6	10.3
	AR	52.0	7.7	52.3	7.2
	WK	54.3	6.7	56.1	5.5
	AD	53.6	11.3	59.3	11.1
	CA	12.1	3.0	13.1	3.2
Unit Diary	FCG	82.0	6.8	86.8	7.1
	CL	110.4	10.5	118.7	9.2
	AR	53.2	7.3	54.4	7.6
	WK	53.9	6.7	57.6	4.7
	AD	53.9	10.6	61.2	10.6
	CA	12.8	3.4	13.5	2.5
Basic Supply Stock	FCG	82.1	7.6	85.4	8.1
	CL	109.3	11.5	119.3	9.2
	AR	53.7	6.6	54.9	6.9
	WK	52.5	6.6	57.3	5.4
	AD	57.4	10.9	61.0	10.7
	CA	11.5	3.3	14.1	3.1
Personal Financial Records	FCG	83.3	7.3	86.4	6.6
	CL	112.8	10.2	119.7	8.2
	AR	51.2	7.2	53.7	7.0
	WK	56.3	5.3	58.3	4.4
	AD	55.1	11.3	60.7	9.4
	CA	12.1	3.1	14.4	2.8

Table 2 Continued

Training Course	Variable	Male Mean	Male SD	Female Mean	Female SD
Aviation Operations	FCG	86.2	5.8	90.8	4.6
	CL	101.7	14.0	116.9	8.3
	AR	49.1	7.4	53.6	6.1
	WK	52.3	6.2	57.3	4.3
	AD	52.8	11.7	59.8	9.7
	CA	10.4	3.1	13.0	3.2
Aviation Maintenance Administration	FCG	77.0	8.1	81.0	6.4
	CL	103.8	13.2	117.4	8.6
	AR	49.6	7.4	51.7	6.9
	WK	52.8	6.1	57.2	5.2
	AD	53.5	11.5	63.0	10.0
	CA	11.0	3.3	13.0	3.0
Aviation Supply	FCG	81.6	8.1	86.3	7.0
	CL	101.7	13.5	115.3	9.8
	AR	49.2	7.6	51.4	7.2
	WK	51.8	6.5	57.5	4.6
	AD	53.1	11.8	60.7	10.9
	CA	10.6	3.1	12.4	2.5
Communications Center	FCG	82.3	7.6	86.0	5.7
	CL	106.0	11.7	114.4	9.4
	AR	49.3	8.0	51.6	8.3
	WK	52.4	7.1	56.3	5.8
	AD	55.9	12.1	60.6	9.8
	CA	11.8	3.4	12.6	3.1

Table 3

Single Predictor Regression Analyses
for Nine Clerical Training
Courses

	Combined			Male			Female		
Predictor	bo	b1	RMSE	bo	b1	RMSE	bo	b1	RMSE
Administrative									
CL	55.66	.25	6.27	59.25	.21	6.39	56.01	.26	5.74
AR	63.82	.38	6.47	63.91	.36	6.41	67.26	.37	5.72
WK	62.42	.39	6.66	64.46	.33	6.66	68.69	.32	6.09
AD	75.85	.14	7.00	77.23	.09	6.99	82.53	.07	6.30
CA	73.83	.45	7.01	78.19	.31	6.98	81.35	.39	6.24
Personnel									
CL	69.51	.18	4.66	70.34	.17	4.89	70.25	.18	3.91
AR	74.20	.30	4.72	73.76	.30	4.91	75.90	.30	3.78
WK	74.77	.27	4.92	73.49	.29	5.06	84.05	.13	4.30
AD	86.32	.06	5.18	85.71	.07	5.37	91.97	-.01	4.36
CA	85.37	.36	5.12	86.08	.26	5.37	85.38	.46	4.09
Unit Diary									
CL	54.24	.25	6.71	65.79	.15	6.67	44.45	.36	6.29
AR	67.35	.30	6.92	69.95	.23	6.65	66.13	.38	6.53
WK	61.08	.41	6.80	67.72	.26	6.62	52.76	.59	6.56
AD	82.46	.02	7.28	88.00	-.11	6.75	82.56	.07	7.11
CA	77.31	.49	7.12	78.04	.31	6.77	76.52	.76	6.89
Basic Supply Stock									
CL	56.49	.24	7.22	58.36	.22	7.17	42.71	.36	7.48
AR	59.23	.42	7.18	60.61	.40	7.13	52.79	.59	7.07
WK	64.35	.34	7.38	65.76	.31	7.31	59.01	.46	7.79
AD	80.41	.04	7.72	80.49	.03	7.59	84.84	.01	8.18
CA	78.03	.37	7.62	78.64	.30	7.53	78.44	.49	8.04

Table 3 Continued

Predictor	Combined bo	Combined bl	Combined RMSE	Male bo	Male bl	Male RMSE	Female bo	Female bl	Female RMSE
Personal Financial Records									
CL	48.32	.31	6.51	52.85	.27	6.74	24.92	.51	5.20
AR	54.79	.54	6.14	55.05	.52	6.24	52.03	.64	4.92
WK	73.32	.19	7.19	76.85	.11	7.26	62.80	.40	6.46
AD	76.07	.14	7.08	76.88	.12	7.16	76.54	.16	6.52
CA	78.70	.42	7.13	79.67	.30	7.22	79.04	.51	6.54
Aviation Operations									
CL	72.33	.14	5.50	74.38	.12	5.56	90.24	.00	4.64
AR	73.90	.26	5.53	73.61	.26	5.47	92.84	-.04	4.64
WK	77.50	.18	5.76	80.08	.12	5.75	94.92	-.07	4.63
AD	80.08	.13	5.67	80.34	.11	5.65	89.81	.02	4.64
CA	85.47	.14	5.85	86.62	-.04	5.79	90.04	.06	4.64
Aviation Maintenance Administration									
CL	54.94	.21	7.47	55.17	.21	7.68	69.02	.10	6.42
AR	54.50	.46	7.24	53.24	.48	7.34	67.41	.26	6.22
WK	58.85	.35	7.71	59.15	.34	7.90	74.50	.11	6.45
AD	73.47	.08	7.96	74.22	.05	8.14	82.35	-.02	6.48
CA	73.85	.34	7.93	73.69	.30	8.11	81.63	-.05	6.48
Aviation Supply									
CL	55.38	.26	7.33	55.01	.26	7.38	69.37	.15	6.88
AR	62.16	.40	7.56	62.21	.39	7.58	68.53	.35	6.56
WK	62.08	.38	7.76	62.28	.37	7.78	91.16	-.08	7.02
AD	74.24	.15	7.97	74.68	.13	8.01	80.99	.09	6.96
CA	79.04	.28	8.11	79.40	.20	8.13	84.08	.18	7.02
Communications Center									
CL	52.78	.28	6.73	53.19	.27	6.90	59.58	.28	5.25
AR	61.56	.43	6.65	60.93	.43	6.78	70.02	.31	5.07
WK	62.12	.39	6.96	62.43	.38	7.11	69.78	.29	5.44
AD	84.01	-.02	7.49	84.49	-.04	7.60	85.99	-.00	5.69
CA	79.20	.30	7.43	78.80	.30	7.55	84.75	.10	5.68

bo = intercept, bl = slope, RMSE = root mean-squared error

Table 4

Regression Models for Multiple Predictors in Nine Clerical Specialties

		Administrative	Personnel	Unit Diary	Supply Stock	P. Fin. Records
AR		.27	.22	.17	.33	.50
WK		.19	.19	.18	.21	.05
AD		.04	.01	-.08	-.00	.04
CA		.23	.27	.36	.26	.19
MF		2.39	3.90	-25.19	-9.62	-18.32
MF*AR		.03	.05	.02	.19	.10
MF*WK		-.01	-.08	.30	.04	.22
MF*AD		-.01	-.03	.12	.02	.02
MF*CA		.03	.12	.28	-.19	.13
CONSTANT		52.61	64.14	63.03	50.19	49.09
RMSE	M	6.23	4.79	6.46	6.96	6.22
	F	5.61	3.66	6.27	7.05	4.75
RSQ	M	.22	.24	.14	.16	.28
	F	.22	.35	.28	.28	.52

		Av. Oper.	Av. Maint.	Av. Supply	Comm. Ctr.
AR		.23	.43	.31	.35
WK		.03	.20	.28	.26
AD		.08	-.00	.11	.01
CA		-.06	.19	.11	.25
MF		24.51	5.96	28.83	16.64
MF*AR		-.26	-.04	.06	-.07
MF*WK		-.08	.04	-.41	-.18
MF*AD		-.07	.08	-.05	.00
MF*CA		.11	-.71	-.30	-.11
CONSTANT		69.61	43.20	44.47	47.98
RMSE	M	5.42	7.29	7.28	6.54
	F	4.81	6.33	6.69	5.14
RSQ	M	.14	.22	.21	.28
	F	.01	.14	.15	.21

Variables with leading MF represent interaction terms.
RMSE = root mean-squared error
RSQ = squared multiple correlation

Table 5

Tests of Differential Prediction
Hypotheses for Nine Marine Corps Training Courses

Predictor	Ho: Parallel F	Rej.Lev.	Ho: Coincident F	Rej.Lev.
Administrative				
CL	2.29	.13	20.47*	.00
AR	.08	.79	61.77*	.00
WK	.05	.83	39.08*	.00
AD	.28	.59	47.86*	.00
CA	.38	.54	55.92*	.00
MULT	.11	.98	10.97*	.00
Personnel				
CL	.02	.89	.96	.39
AR	.00	.99	3.53*	.03
WK	1.11	.29	2.75*	.07
AD	.84	.36	2.76*	.07
CA	.53	.47	2.59*	.08
MULT	.22	.93	.91	.48
Unit Diary				
CL	6.34*	.07	--	--
AR	1.00	.32	8.07*	.00
WK	2.21	.14	5.61*	.00
AD	2.57	.11	9.74*	.00
CA	1.07	.30	7.73*	.00
MULT	.89	.47	2.40*	.04
Basic Supply Stock				
CL	3.18*	.07	--	--
AR	3.28*	.07	--	--
WK	1.16	.28	3.20*	.04
AD	.06	.80	8.41*	.00
CA	.59	.44	5.11*	.01
MULT	.87	.48	1.20	.30
Personal Financial Records				
CL	5.07*	.03	--	--
AR	.96	.33	8.21*	.00
WK	1.68	.20	4.49*	.01
AD	.19	.66	2.82*	.06
CA	.35	.55	2.57*	.08
MULT	.68	.60	1.97*	.08

Table 5 Continued

Predictor	Ho: Parallel F	Rej.Lev.	Ho: Coincident F	Rej.Lev.
Aviation Operations				
CL	1.14	.29	4.96*	.01
AR	4.08*	.04	--	--
WK	.81	.37	9.04*	.00
AD	1.01	.32	9.02*	.00
CA	.11	.74	11.12*	.00
MULT	1.05	.38	2.86*	.02
Aviation Maintenance Administration				
CL	.47	.49	.54	.58
AR	1.23	.27	2.99*	.05
WK	.67	.42	1.78	.17
AD	.26	.61	2.65*	.07
CA	.53	.47	2.79*	.06
MULT	.71	.59	.90	.48
Aviation Supply				
CL	1.00	.32	1.14	.32
AR	.09	.76	5.96*	.00
WK	3.46*	.06	--	--
AD	.15	.70	4.90*	.01
CA	.00	.96	6.36*	.00
MULT	1.00	.41	1.16	.33
Communications Center				
CL	.28	.60	1.51	.22
AR	1.68	.20	6.91*	.00
WK	.43	.51	3.74*	.02
AD	.19	.66	9.48*	.00
CA	.51	.48	8.16*	.00
MULT	.91	.46	1.71	.13

* Indicates rejection of Ho at alpha = .10.

Table 6

Johnson-Neyman Regions of Rejection for
Nine Clerical Training Courses

Training Course	Predictor	Region of Rejection	Proportion Affected Total	Proportion Affected Female
Administrative	CL	CL > 92	.90	.86
	AR	20 < AR < 80	1.00	1.00
	WK	20 < WK < 80	1.00	1.00
	AD	20 < AD < 80	1.00	1.00
	CA	0 < CA < 20	1.00	1.00
Personnel	CL	No Region	----	----
	AR	43 < AR < 61	.69	.73
	WK	40 < WK < 57	.55	.53
	AD	34 < AD < 59	.62	.42
	CA	12 < CA < 18	.44	.53
Unit Diary	CL	CL > 112	.58	.81
	AR	AR > 46	.77	.79
	WK	WK > 53	.60	.73
	AD	AD > 48	.78	.88
	CA	11 < CA < 20	.56	.69
Basic Supply Stock	CL	CL > 116	.33	.67
	AR	AR > 48	.73	.76
	WK	55 < WK < 77	.39	.65
	AD	AD > 31	.99	.99
	CA	CA > 11	.50	.79
Personal Financial Records	CL	CL < 99 or CL > 123	.26	.44
	AR	AR > 45	.88	.87
	WK	WK > 55	.64	.71
	AD	AD > 53	.60	.79
	CA	12 < CA < 19	.48	.67
Aviation Operations	CL	69 < CL < 124	.90	.74
	AR	AR < 58	.84	.74
	WK	31 < WK < 64	.97	.95
	AD	AD < 73	.94	.93
	CA	CA > 5	.98	1.00
Aviation Maintenance Administration	CL	No Region	---	---
	AR	26 < AR < 54	.71	.62
	WK	49 < WK < 57	.41	.32
	AD	46 < AD < 68	.60	.62
	CA	6 < CA < 14	.67	.38
Aviation Supply	CL	No Region	---	---
	AR	No Region	---	---
	WK	WK < 59	.79	.52
	AD	36 < AD < 74	.84	.82
	CA	7 < CA < 17	.82	.96
Communications Center	CL	No Region	---	---
	AR	AR < 59	.82	.75
	WK	42 < WK < 60	.68	.60
	AD	AD > 41	.88	.98
	CA	CA < 17	.90	.88

Table 7

Comparison of Male and Female
Predictions at the Female Mean
(Female SD Units)

Training Course	Predictor CL	AR	WK	AD	CA	MULT
Administrative	-.40	-.64	-.55	-.64	-.68	-.51
Personnel	-.27	-.50	-.40	-.43	-.46	-.42
Unit Diary	-.50	-.64	-.54	-.79	-.64	-.61
Supply Stock	-.14	-.35	-.22	-.40	-.31	-.20
Pers. Fin. Rcds.	-.18	-.50	-.42	-.36	-.35	-.45
Av. Operations	-.62	-.76	-.88	-.84	-1.03	-.70
Av. Maintenance	-.17	-.45	-.38	-.53	-.52	-.31
Av. Supply	-.17	-.55	-.37	-.53	-.63	-.23
Comm. Center	-.24	-.48	-.39	-.68	-.61	-.26
Weighted Mean*	-.33	-.57	-.48	-.59	-.60	-.44

*Female sample sizes used as weights.

Table 8

Regression Models for AR and WK
in Nine Clerical Specialties

		Adminis-trative	Personnel	Unit Diary	Supply Stock	P. Fin. Records
AR		.29	.23	.16	.34	.52
WK		.19	.17	.20	.21	.05
MF		2.77	3.72	-13.83	-10.56	-16.17
MF*AR		.04	.06	.11	.20	.10
MF*WK		- .02	- .09	.20	.03	.24
CONSTANT		56.98	67.94	62.93	52.72	52.43
RMSE	M	6.29	4.82	6.56	7.00	6.24
	F	5.66	3.80	6.37	6.99	4.80
RSQ	M	.21	.22	.09	.15	.27
	F	.20	.26	.22	.28	.50

		Av. Oper.	Av. Maint.	Av. Supply	Comm. Ctr.
AR		.25	.44	.33	.36
WK		.06	.20	.27	.24
MF		24.34	14.24	26.23	16.45
MF*AR		- .27	- .17	.03	- .07
MF*WK		- .12	- .06	- .44	- .19
CONSTANT		71.16	44.88	51.23	51.69
RMSE	M	5.48	7.27	7.40	6.58
	F	4.69	6.27	6.58	5.09
RSQ	M	.10	.21	.18	.25
	F	.01	.09	.14	.21

Table 9

Hypothesis Tests of Parallel and Coincident Regressions for AR and WK

Course	Ho: Parallel F	Rej.Lev.	Ho: Coincident F	Rej.Lev.
Administrative	.26	.77	29.44*	.00
Personnel	.27	.77	2.05	.11
Unit Diary	.99	.37	3.97*	.01
B. Supply	1.90	.15	3.35*	.02
Fin. Rcds.	1.28	.29	5.40*	.00
Av. Oper.	2.23	.11	5.78*	.00
Av. Maint.	.39	.68	1.06	.37
Av. Supply	1.74	.18	2.87*	.04
Comm. Ctr.	2.00	.14	3.55*	.01

* Indicates rejection of Ho at alpha = .10.

Table 10

Comparisons of Male and Female
Predictions at the Female Mean
(Female SD Units)

Training Course	Total Sample CL	Total Sample AR/WK	HS Graduates CL	HS Graduates AR/WK
Administrative	-.40	-.62	-.21	-.47
Personnel	-.27	-.34	-.19	-.28
Unit Diary	-.50	-.81	-.25	-.50
Supply Stock	-.14	-.35	-.14	-.28
Pers. Fin. Rcds.	-.18	-.74	-.17	-.71
Av. Operations	-.62	-.74	-.59	-.70
Av. Maintenance	-.17	-.40	-.06	-.26
Av. Supply	-.17	-.53	.06	-.20
Comm. Center	-.24	-.33	-.05	-.16
Weighted Mean*	-.33	-.56	-.18	-.42

*Female sample sizes used as weights.

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